

3D Real-time design environments for interactive morphogenesis of architectural space

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In this investigation we are concerned with rethinking and proposing the concept of space towards an enhanced interactive place where our spatial surroundings are no longer understood as fixed but as living organisms that adapt to our interactions inside of them. It is the aim of the research to show a space created by the interaction of the users with the building rather than the one generated by the personal interpretation of the designer. A place co-created by its inhabitant in real-time through a virtual prototype. Hereby, we are interested in investigating human-computer interaction in the context of game engines as a morphogenetic process for potential architectural design and space conception.

This research not only underlines theoretical concepts of architecture and folding as a spatio-structural diagrams that generate emergent processes in architecture design, but also proposes the creation and further development of a prototype based on the potential that computer games and multimedia afford for experimenting and determining architectural environments. With the potential of 3D Real-Time engines as design environments for the co-development of user driven spaces and folding as a design formation attitude we aim to determine space through the experience of creating a prototype.

Keywords: *Interactive architecture; 3D real-time design environments; Space Folding; User driven spaces; Virtual Collaborative Design.*

Background

Communicating spaces implies a closer look at the actual technological and theoretical concepts and the way they affect architectural design conception. What these concepts are bringing to architecture are new spaces that allow new ways of spatial existence, new types of presence, new ways of living together. Interacting in real-time inside this new places challenges space, spatiality and inhabitation.

In the same way, interactivity is questioning today's practice as a new threshold between the digital and the physical, but independently of the digital conditions of the new space, architecture's principal aim is to deal with humans in real space. For this reason, a new digital interactive space will be only a place to enhance real space, a place capable to experiment and test future conditions in order to retrieve alternatives to architecture.

Architectural design of digital interactive spaces

Bernard Cache proposes a search for a new definition of the technological object, the “objectile” as an “event- assuming place that no longer refers to a spatial mould but to a temporal modulation that implies as much the beginning of a continuous variation of matter as a continuous development of form” (Cache, 2005).

In addition, real-time engines as photo-realistic interactive environments, a mixture of physical/digital interactions with real-time/on-line experience of space, allows us to simulate real and continuously changing conditions decreasing the dichotomy between the physical and the digital world where both have to work together and support each other towards architecture as a joint real / virtual interface. So to answer the questions: how is architecture conceived by 3D real-time engines and interaction? And how does the idea of interactivity transform itself into architecture and vice versa? These questions must be answered through an interactive experimentation process, in which, the answer cannot be predicted but the system can be described by rules inside an “objectile prototype”. This interactive process allows temporal and continuous development of space form. Therefore, the outcome of this interactive process is not predictable, it is an uncertainty that has to be played with and tested in real-time where billions of possible outcomes are just part of the unexpected, the unfolding architectural meaning. As a result, and as Oosterhuis states in his article “Swarm Architecture II” an interactive digital space is based on a set of rules, parameters, and behaviours that control a running process of a complex adaptive system.

It is the aim of the paper to be aware of the continuous and inherit changes of use and demand of space, but also of the emergent models and processes for the creation of artificial systems designed to produce form (Hensel, Menges and Weinstock, 2004). Consequently, we aim to define a prototype that will help to develop and test possible living en-

vironments. A space flexible enough to evolve over time, to change in time, continuously that will lead us to a new space of evolutions that is meant to interact, self-form and self-shape.

In summary, in this search for a system that simulates motion we want to propose a structure capable to implement digital technologies that enhance design through experiencing architecture in computer games by interactive processes where people as forces perceive and interact with space as part of architectural design and space/form conception. “Rather than being designed as stationary inert form, space is highly plastic, flexible, and mutable in its dynamic evolution through motion and transformation” (Lynn, 1999).

Space (Digital-Physical)

Today’s spatial surroundings are living organisms consisting of both digital and physical space in close and dynamic coexistence. Our daily interaction with these environments, call for a new way of understanding the relation between space and technology. In this way, design processes and solutions take part in digital space, enabling the conception of architecture as the interface for human and technological resources¹.

It is expressed by Deleuze, in his notion of “any-space-whatever” that space is fragmented, not connected clearly from one to another, making possible to relate them in many different ways to themselves and to the environment (Deleuze, 1986). As a result, it can be argued that the digital space announces and stages the disappearance of the place that we know; the new place becomes non-linear, interactive.

Interaction (Co-creation)

If architecture principally investigates the relationships that occur inside space (Mazzi, 1993), “the free-

¹ <http://www.oosterhuis.nl/quickstart/index.php?id=266> , Jun 2006

dom of interacting with space in real-time may be nothing but the ability to go beyond all the limitations of the present conceptions of space" (Sommerer and Mignonneau, 1997). Similarly, digital space is created by a generative sequence between human-space, space-computer and computer-human interactions.

Understanding the properties and variables of the space, a system of interactions can modify architectural principles, what at the same time changes the approach to architectural design. "Architecture is not only knowledge of space but also a space of knowledge" (Grosz, 2001). For this reason, an interactive scripted 3D parametric model, instead of drawings, should portrait and appropriate ways of developing an interactive architectural space. As Oosterhuis states in his essay "Swarm Architecture I" "The designers design the rules of the game, and at the end of the project, they play the game. They design the design".

Prototype

It is implied by Manuel Delanda, "in a sense, evolutionary simulations replace design, since artists can use it to create new forms rather than to design them" (Delanda, 2002). Therefore, we aim to reach a space that incorporates possibilities and needs to change, a space that is not fixed or even finished, a space always in the process of becoming; it is a space that can and should be designed in a mediatic and interactive way.

The prototype is a digital projection of the visual explorations on "Folding architecture: Spatial, Structural and organisational diagrams" at Delft University of technology (Vyzoviti, 2004). Based on this visual essay and the theoretical concepts stated we propose a Morphogenetic process, an interactive user experimentation of surfaces that are controlled by a chain of bones in an Inverse kinematic animation method. The bones not only state a structural approach to a future, perhaps, pneumatic system that expands and contracts allowing

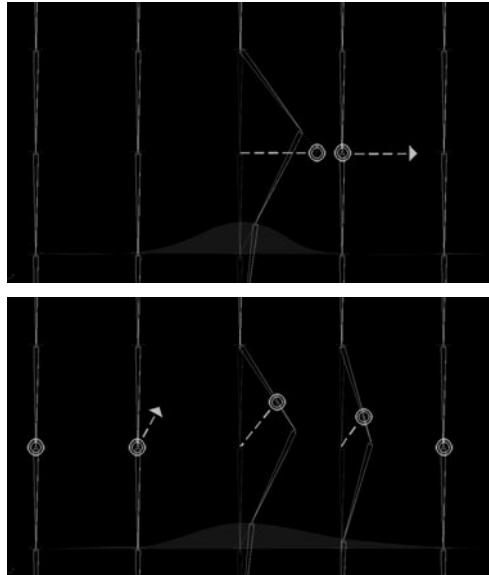


Figure 1
Separation: Steer to avoid crowding other junctions

Figure 2
Alignment: Steer towards the average heading of others junctions

surfaces to transform, but also defines a network of junctions between bones that behaves and interacts as part of swarm. This behavioural model of junctions is founded on the simulation's principles of coordinated animal motion that Craig Reynolds developed for film and TV industry². At the same time that the junctions control the bones and the bones control the surface, a set of rules and parameters controls the behaviours of the junctions, generating an integrated system that interacts with the users of the space.

Meanwhile, the users move around the space triggering the junctions to move and to interact between each other. Within this surface digital folding exploration and two-way communication of movement, the reaction of the junctions to the user's interactions transforms and generates space. To some extent, the users are just another system of many that could interact with an infinite number of other particle or force systems (e.g. wind, sun, earthquakes, etc.)

In order to control the junctions a set of rules

² <http://www.red3d.com/cwr/boids/>: Jun 2006

Figure 3
Cohesion: Steer to move towards the average position of other junctions

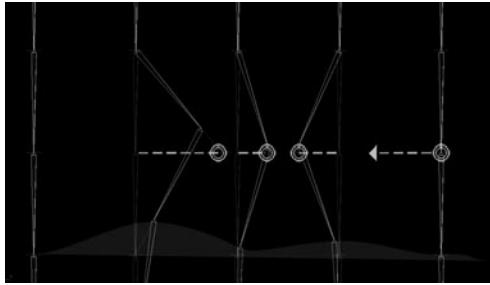


Figure 4
Radius: Radius: Area of interaction and influence

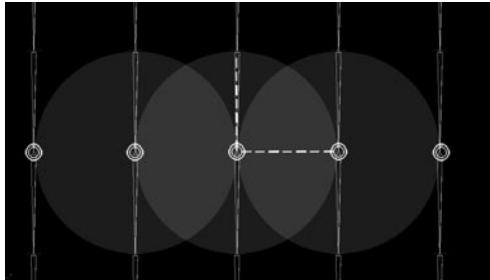


Figure 5
Surfaces & chain of bones

and behaviours are defined:

The way the space is altered, not only depends in the way the users navigate the site, but also, in the way the chains of bones are related and the surfaces answer to inputs and out puts of the system. As a result, similar conditions may produce multiple different solutions that offer alternatives to this data-driven "objectile". Chains of components exchange data and propose new configurations as the outcome of the process.

Conclusions

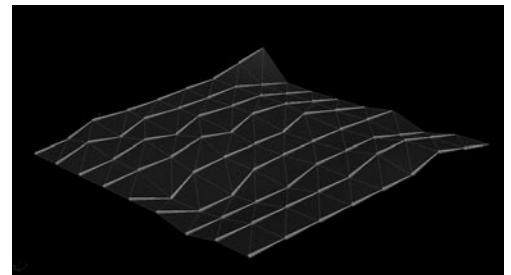
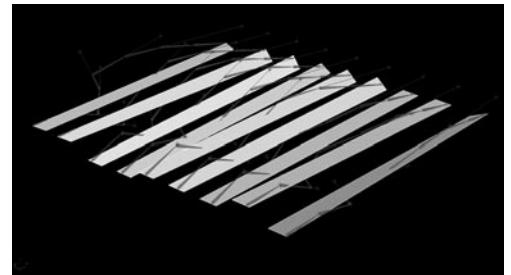
New technologies and theoretical concepts are changing the way we approach architecture. Spatial simulations using game engines, programming and mediatic tools, offer a possible approach to test implementations of interactive conditions into space. In the same way, playing online in real-time and programming a complete set of new multimedia and spatial interactions just bring to the scene options to architecture not only to visualize it but also to con-

Figure 6
Surface & network of bones.

struct it while playing.

By testing and implementing behaviors, forces and systems, the essence of the architect as an author is questioned. Architecture is not necessarily about an arbitrary esthetic choice, and may be more related to the conception of variables and possibilities that the environment and the users may dictate. Architects are the co-authors of a new way of understanding the relation between space and technology

The "objectile Prototype" is conceived as an event-assuming place that sets rules for a continuous variation of space as a continuous adaptive and emergent process. Its theoretical description already starts to generate possibilities to envisage spatial form explorations based on digital interactions. In summary, we aim to reach a space that incorporates possibilities and needs to change, a space that is not fixed or even finished, a space always in the process of becoming; a space designed in an interactive



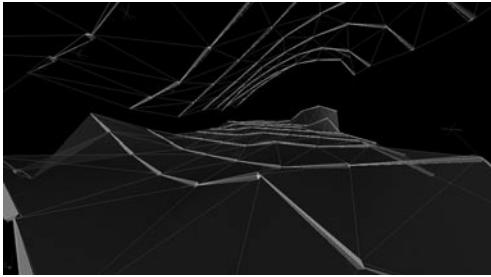


Figure 7
Folded Surfaces

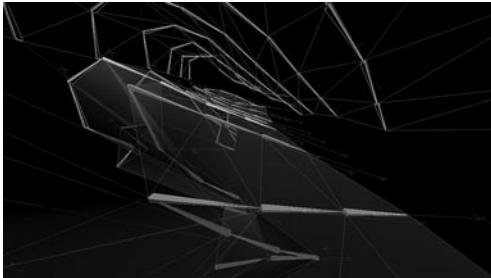


Figure 8
Folded Surfaces

way.

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